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(54) Title: HIGH BANDWIDTH DELIVERY AND INTERNET ACCESS FOR AIRBORNE PASSENGERS
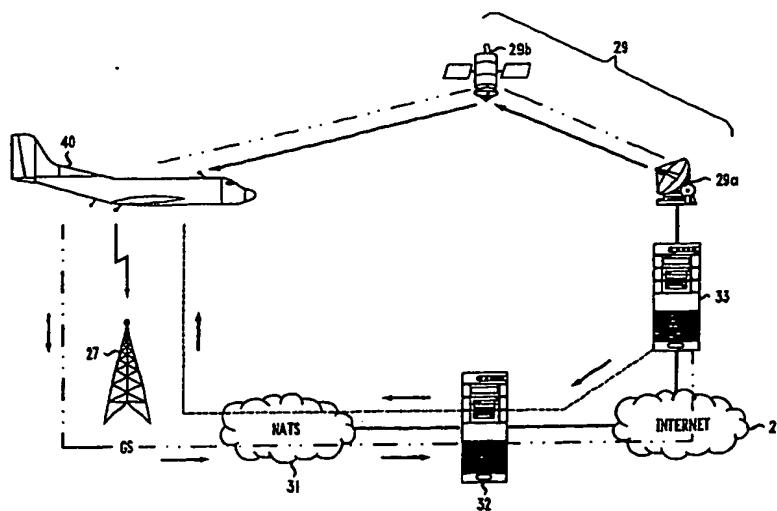
(57) Abstract

A method and a communications system in which a request for data transmitted by an airborne transmitter over a low-bandwidth air-to-ground communication system uplink and received by a ground-based receiver. The requested data is then transmitted over a high-bandwidth communication system downlink, such as a DBS satellite system downlink, preferably using an MPEG-2 compression technique, and received by an airborne receiver located on the same aircraft as the airborne transmitter. The received request for data is transmitted to a data network that contains the requested data, such as the Internet or a private data network, using circuit-switched techniques. According to the invention, the requested data includes one of video information, audio information and textual information.

HIGH BANDWIDTH DELIVERY AND INTERNET ACCESS FOR AIRBORNE PASSENGERS

CROSS REFERENCE TO RELATED APPLICATIONS

5   The present application is related to copending

application Serial Number (Attorney Docket LEUCA 2-7), filed

concurrently, and commonly assigned with the present invention.

BACKGROUND OF THE INVENTION

10   **1. Field of the Invention**

The present invention relates to the field of

telecommunications. More particularly, the present invention relates to

a method and to a system for communicating between an airborne data

terminal and a ground-based computer network.

15   **2. Description of Related Art**

The ability for passengers on a commercial airline flight

to make phone calls is well-known. Initially, such airborne telephone

calls utilized an analog technology that was similar to that used by an

airborne radio station broadcasting a modulated voice signal over a

20   designated frequency to a ground-based station. The ground station

interfaced with a Public Switched Telephony Network (PSTN) to

complete the call. The analog approach suffers from problems

associated with signal degradation, and requires a relatively large bandwidth for carrying a voice band signal.

An all digital air-to-ground telephony network service was introduced in 1993 in which voice signals are carried by an ISDN

5   link on an aircraft to a radio link. Modern digital transmission and speech processing techniques are used on the voice signals before an airborne radio transmitter transmits an encoded digital voice signal to the ground where the voice signal is routed to the PSTN. The digital approach delivers a clearer voice quality than the analog approach, and

10 allows evolving speech encoding techniques to carry more simultaneous voice calls over available communication channels.

At the time the all digital air-to-ground service was introduced, the only data service envisioned was facsimile and data modem-type calls to be made to ground-based stations or terminals.

15 To accommodate existing facsimile and data modems that might be used on an aircraft for sending facsimile documents or for retrieving e-mail messages, a voice encoder on the aircraft used for voice calls is bypassed with a proper rate adaptation so that modem signals are send over the radio link. Still, this type of connection is considered to be a

20 circuit-switched voice call, that is, each dialup consumes one standard voice channel. As a result, the tariff for a conventional airborne data

service call is the same as the tariff for a standard voice call because

thē procedure for setting up the two types of calls is the same, and the

bandwidth that is consumed by a conventional airborne data call is the

same as the bandwidth consumed by a standard voice call. Further, the

5   types of data services that are conveniently available through

conventional airborne data service calls are severely limited because of

the limited bandwidth available for a conventional airborne data call.

For example, conventional airborne data services do not provide a

bandwidth that is sufficient for supporting, for example, access to the

10   Internet in which graphics, audio, video, textual and multimedia

content are available.

What is needed is a way to provide an integrated

voice/data service to airborne passengers that can mix various data

services, such as accessing the Internet or placing a voice call, and

15   thereby utilize the limited air channels available to airborne passengers

more efficiently.

SUMMARY OF THE INVENTION

The present invention provides a method and a

20   communications system that provides an integrated voice/data service

to airborne passengers that can mix various data services, such as

accessing the Internet or placing a voice call, and thereby efficiently utilizing the air channels available to airborne passengers.

The advantages of the present invention are provided by a method and a communications system in which a request for data

5   transmitted by an airborne transmitter over a low-bandwidth air-to-ground communication system uplink and received by a ground-based receiver. The requested data is then transmitted over a high-bandwidth communication system downlink, such as a DBS satellite system downlink, preferably using an MPEG-2 compression technique, and

10 received by an airborne receiver located on the same aircraft as the airborne transmitter. The received request for data is transmitted to a data network that contains the requested data, such as the Internet or a private data network, using circuit-switched techniques. The requests from all active data users are multiplexed on the same circuit-switched

15 channel, thus conserving the bandwidth for normal voice channels. According to the invention, the requested data includes one of video information, audio information and textual information.

BRIEF DESCRIPTION OF THE DRAWINGS

5

The present invention is illustrated by way of example

and not limitation in the accompanying figures in which like reference

numerals indicate similar elements and in which:

Figure 1 shows a schematic block diagram of a

5   telecommunications system that provides an air-to-ground

communication link between an airborne telecommunication data

terminal and a ground-based network according to the present

invention; and

Figure 2 is a diagram of a preferred configuration of a

10   telecommunications system providing an NATS-type packet data

network uplink and a DBS-type system downlink according to the

present invention.

6

DETAILED DESCRIPTION

The present invention provides a method and a system

providing two-way data communications between an airborne data

terminal station, such as a personal computer (PC) or a laptop

5   computer, and a ground-based data network, such as the Internet, using

a packet data switching technology. As a result, the present invention

utilizes available air-to-ground bandwidth more efficiently than

conventional airborne data telecommunications systems because the

same air-to-ground channel is used for multiplexing data packets from

10   different concurrent user data sessions.

Figure 1 shows a schematic block diagram of a

telecommunications system 10 that provides an air-to-ground

communication link between an airborne data terminal 11, such as a

PC or a laptop computer, and a ground-based network 2, such as the

15   Internet. According to the invention, system 10 is located on an

airborne platform, such as an airplane, a helicopter or a space vehicle,

and includes a data transport mechanism, a data server mechanism and

an Application Programming Interface (API) function. The API

function is used by an external application for interacting with the data

20   server mechanism for call control functions and for performing

Operation, Administration, Maintenance and Provisioning (OAM&P)

functions.

The data transport mechanism provides interfaces to and

includes various data pipes that are both internal and external to the

5   aircraft. The internal data pipes link passengers and aircraft personnel

to a data server. According to the invention, the internal data pipes

can be any of an existing Cabin Distribution System (CDS) using an

Integrated Services Digital Network (ISDN), a Local Area Network

(LAN), an Ethernet or a Fiber Distributed Data Interface (FDDI)

10   network, and/or an Asynchronous Tranmission Mode (ATM) network

for distributing video, voice/audio, and textual data signals to a display

screen located, for example, on the back of passenger seats.

Preferably, an ATM internal data pipe uses an embedded open standard

Operating System, such as JAVA.

15   The external pipes can be various wireless pipes, or air

links, to a ground-based station or gateway, or to a satellite system.

According to the invention, the different external pipes that can be used

with the present invention can be an existing terrestrial link system,

such as the North American Terrestrial System (NATS) or the

20   European Terrestrial Flight Telephone System (TFTS), a direct air link

to a terrestrial gateway, a link to a Low Earth Orbit (LEO) and/or a

Medium Earth Orbit (MEO) satellite system, and/or a link to one of the

emerging broadband Satellite-based systems, such as the Digital

Broadcast Satellite (DBS) or Teledesic systems.

In Figure 1, system 10 includes a plurality of airborne

5   data terminals 11, each of which are connected to a data server 12 by

an internal data pipe 13, such as an Ethernet, in a well-known manner.

Data terminals 11 can be data terminals 11a, 11b and 11c that are used

by flight crew and personnel and data terminals 11e, 11f and 11g that

are used by passengers. For example, data terminal 11a is located on

10   the flight deck of the aircraft, while data terminals 11b and 11c are

located elsewhere in the aircraft and are used by a maintenance crew

and/or members of the flight crew not located on the flight deck. Data

terminals 11d, 11e and 11f are dedicated data terminals provided on-

board the aircraft for the convenience of passengers and/or can be

15   portable or laptop computers provided by passengers.

Data server 12 acts as an intelligent airborne gateway

and performs multiplexing and necessary call control functions. More

specifically, data server 12 provides three general functions: 1)

controlling various data transport interfaces; 2) multiplexing, routing,

20   and priority queuing functions for data packets; and 3) updating and

maintaining various databases depending on the application as an off-

line process and for providing a uniform user interface capability (API)

to client applications. Examples of off-line processes provided by data

server 12 are a HyperText Transport Protocol (HTTP) process that

provides an interface for Web browsing and an Aircraft Condition

5   Monitoring System (ACMS) process for collecting aircraft flight data

for OA&M purposes.

Data server 12 preferably includes a network interface

circuit (NIC) 14, a router 15, a database 16, and at least one and

preferably a plurality of data transport interface circuits 17-20.

10 Network interface circuit 14 connects data server 12 to internal data

pipe 13 in a well-known manner, and provides data packets received

from data pipe 13 to router 15. Router 15 uses a routing table that is

stored in routing table database 16 for directing data packets received

from terminals 11a-11f and voice packets from telephones (not shown)

15 to an appropriate data transport interface circuit 17-20 based on a

requested data service for subsequent transmission to a particular

bearer service. The components forming data server 12 can be

physically enclosed within one housing or enclosure, or can be

physically located in separate housings that are distributed around the

20 aircraft depending on the technology used, the applications, and the

physical constraints of the aircraft.

In Figure 1, gate link interface circuit 17 provides well-known interface functions for an air link through an antenna 21 directly to a ground-based gateway 22. Gateway 22 is connected to data network 2, such as the Internet. Similarly, Satellite Interface Circuit

5   (SIC) 18 provides well-known interface functions for an air link through an antenna 23 to a satellite network 24, such as an LEO or MEO satellite system. Satellite network 24 is connected to data network 2 through a ground station 24a that is a part of network 24. Exemplary satellite networks suitable for satellite network 24 include

10   several LEO/MEO systems that are designed primarily for voice service, such as the Iridium, Globalstar, ICO and Odyssey systems. The data service provided by these exemplary satellite systems is supported only as a supplementary service having a bit rate between 1.2 to 9.6 Kbps using voice band modem signaling similar to the

15   conventional two-way data services available from the NATS, TFTS and SATCOM.

NATS interface circuit 19 provides well-known interface functions for an air link through an Aircraft Communication Unit (ACU) 496 NATS unit 25 and an antenna 26 to a gateway 27 of an

20   NATS-type system 31, such as AT&T's NATS network. NATS-type system 31 is connected to data network 2 using a packet data transport

mechanism. The AT&T's NATS network includes approximately 150

ground stations covering the entire continental United States and parts

of the Canada and Mexico. All NATS ground stations are

interconnected to a switching center located in New Jersey from where

5   voice traffic is routed to a PSTN. The NATS ground stations are also

interconnected through a frame relay network to data centers, or

gateways, where the data packets are routed to a private data network

or to public data network 2, such as the Internet. Using a modern

protocol, such as MPP combined with PPTP or L2TP, the NATS

10   network supports an aggregated dynamic bandwidth of up to 290 Kbps

in a channel block of 29 channels, subject to channel availability.

DBS decoder interface circuit 20 provides well-known

interface functions for an air link through an antenna 28 to a DBS

satellite system 29. DBS satellite system 29 is connected to data

15   network 2. The broadband satellite systems, such as the Geo-

synchronous Earth Orbit (GEO) Digital Broadcast Satellite (DBS), are

envisioned as providing a one-way data service as the primary service.

DBS technology uses an MPEG-2 digital compression system for

sending a plurality of channels of digitized video signals through one

20   transponder. The MPEG-2 digital compression system can be used for

multiplexing any digital signal, including a packet data signal, and for

intermixing a digital signal with a video signal for satellite

broadcasting. From the point of view of the DBS system is concerned,

there is no difference whether a transported signal is a compressed

video signal or a sequence of IP packets.

5   .   .   Antenna 28 used on the aircraft must be a moving or a

phased-array antenna for maintaining a line-of-sight with a transmitting

satellite because DBS system is a GEO satellite system. An antenna of

this type is relatively more costly than a standard fixed antenna. For

other satellite systems, such as the Low Earth Orbit (LEO) satellites

10   that are not geo-synchronous, the satellite system handles handoffs,

therefore, eliminating the need for a moving-type antenna for antenna

23.

To provide an interactive airborne data service, such as

e-mail retrieval or Web browsing, the present invention uses an NATS-

15   type packet data network, such as the AT&T NATS, for an uplink data

pipe and a DBS-type system for a downlink data pipe. For a typical

application, the relative size, or bandwidth requirement, of the data

request is small, while the amount of data returned in response to the

request is relatively large. The capability of the NATS link is

20   sufficient for carrying a request for data, but is insufficient for carrying

the requested data. Alternatively, the uplink data pipe can be through

an LEO/MEO satellite network 24, with-the downlink data pipe being

through DBS-type system 29.

Figure 2 is a diagram of a preferred configuration of a

telecommunications system providing an NATS-type packet data

5   network uplink data pipe and a DBS-type system downlink data pipe

according to the present invention. System 10 uses an MPP technique

that aggregates multiple on-demand 9.6 Kbps bandwidth upstream links

from aircraft 40 to NATS system 31. Downstream links in excess of 5

Mbps bandwidth from the network are provided through the DBS

10   system to the aircraft. IP packets are encapsulated by lower layer

protocols so that there is a transparent conduit for IP packets to be

transported from the aircraft to a desired host and from a host to the

aircraft via a DBS link.

In Figure 2, a user using a laptop computer on airplane

15   40 that is connected to system 10 sends an uplink data request for

establishing a high-speed data session through NATS system 31. The

request is sent through a second gateway 32 to a desired access

management server 33. After a proper authentication process and

channel assignment, access management server 33 sends a service

20   initiation acknowledgement message to the laptop computer via NATS

system 31 and terrestrial gateway 27. The laptop computer receives

the service initiation acknowledgement message via NATS interface
circuit 19, router 15 and internal data pipe 13 (Figure 1). The laptop
computer sends a request to a particular website on Internet 2 via
NATS system 31. The desired website responds to the data request by

5   sending the data requested to an access management server 33 that is
connected to a DBS system 29. The requested data is transmitted from
a ground station 29a to DBS satellite 29b, then to aircraft 40. The
laptop computer receives the requested data from DBS interface circuit
20, router 15 and internal data pipe 13.

10   System 10 utilizes the advantages of the data
compression features of DBS system 29 when downloading broadband
data from a DBS satellite. An exemplary application that can be
utilized by a flight crew is software downloading, flight information
updates, etc. In-Flight Entertainment (IFE) services offered by an

15   airline can receive real-time video programs from a direct television-
type service, or by allowing passengers to browse the Internet with
ample bandwidth.

             Presently, the available DBS systems are broadcast-only
systems. When a two-way DBS satellite link is available, data server

20   12 will treat such an uplink as another bearer service and uses the
satellite broadband network for interconnecting aircraft 40 to a ground-

based gateway. The bandwidth available with the two-way broadband

satellite systems supports applications, such as video conferencing,

high-quality video, high-speed Internet, and virtual LAN to the

aircraft. An added advantage of using any of satellite systems 24, 29 is

5   that universal access is possible so that the same system can be used

anywhere on earth. For this embodiment of the present invention, the

satellite network is connected to the mobile terminal on-board the

aircraft, handling routing and handoffs needed for linking the mobile

terminal on-board the aircraft to a ground-based gateway in a well-

10   known manner similar to that used by conventional cellular telephone

system, instead of a network of ground stations that connect the

gateway. As long as an aircraft and a gateway can connect by way of a

satellite network, SVCs or PVCs can be set up between any pair of

terminal stations. For example, one aircraft can have an SVC to

15   another aircraft as long as both aircraft are serviced by the satellite

system. Similarly, an aircraft can have an SVC to any gateway as long

as both can be connected through the satellite system.

       The API function of the present invention is provided by

a collection of APIs or procedures having a standardized execution

20   environment, and can be executed by applications, whether local or

remote, for allowing the configuration of call/data routes, monitoring

and reporting of activities, and messaging and presentation of data to users. An example of an API that can be used with the present invention are JAVA applets that can be executed by any JAVA-capable Web browser for allowing a flight crew to view the latest gate link

5 information or for ground control personnel to view the vital statistics of the aircraft in real time.

The API function of the present invention is the enabling tool for allowing quick introduction of new applications and/or services, for developing specific applications for call monitoring and

10 control purposes, and for incorporating new technologies without significant development effort. The APIs used with the present invention are highly modularized so that any combination of APIs can be incorporated into creating new applications without having impact on existing applications.

15 Preferably, the present invention uses the TCP/IP protocol as a networking protocol, thus allowing interconnection to virtually any network. An additional advantage of the present invention is that the ability to access to the vast collection of TCP/IP protocols, tools and applications provides the present invention with

20 the flexibility to meet the needs of future aircraft data services. The present invention is expandable by providing an infrastructure that is

modularized and is designed to use Open System interfaces, allowing

new hardware and technologies to be incorporated with minimal

development. Preferably, the present invention uses COTS hardware

and software.

18

THE CLAIMS

What is claimed is:

       1.   A method for communicating data, the method comprising the steps of:

5   receiving a request for data over a low-bandwidth air-to-ground communication system uplink; and

             transmitting the requested data over a high-bandwidth communication system downlink.

10   2.   The method according to claim 1, wherein the high-bandwidth communication system downlink is a satellite downlink.

       3.   The method according to claim 2, wherein the satellite system downlink is part of a DBS satellite system.

15

       4.   The method according to claim 2, further comprising the step of transmitting the received request for data to a data network for obtaining the requested data, the data network containing the requested data.

20

5.   The method according to claim 4, wherein the data

network is the Internet.

6.   The method according to claim 4, wherein the data

5   network is a private network.

7.   The method according to claim 4, further comprising the

steps of:

transmitting the request for data from an airborne

10   transmitter; and

receiving the requested data over the high-bandwidth

communication system link by an airborne receiver, the airborne

transmitter and the airborne receiver being on the same aircraft.

15   8.   The method according to claim 7, wherein the step of

transmitting the received request for data to the data network includes

the step of using circuit-switched techniques for transmitting the

received request for data to the data network.

20   9.   The method according to claim 8, wherein the step of

transmitting the requested data over the high-bandwidth communication

system downlink includes the step of using an MPEG-2 compression technique for transmitting the requested data over the high-bandwidth communication system downlink.

5   10.   The method according to claim 4, wherein the requested data includes one of video information, audio information and textual information.

         11.   A communications system, comprising:

10   a ground-based receiver receiving a request for data over a low-bandwidth air-to-ground communication system uplink;

                 a transmitter transmitting the requested data over a high-bandwidth communication system downlink.

15   12.   The system according to claim 11, wherein the high-bandwidth communication system downlink is a satellite downlink.

         13.   The system according to claim 12, wherein the satellite system downlink is part of a DBS satellite system.

20

         14.   The system according to claim 12, further comprising:

a data network containing the requested data; and

a bearer carrier system sending the received request for

data to the data network.

5   15.   The system according to claim 14, wherein the data

network is the Internet.

16.   The system according to claim 14, wherein the data

network is a private network.

10

17.   The system according to claim 14, further comprising:

an airborne transmitter transmitting the request for data;

and

an airborne receiver receiving the requested data over

15   the high-bandwidth communication system link, the airborne

transmitter and the airborne receiver being on the same aircraft.


18.   The system according to claim 17, further comprising a

circuit-switched communications network connected to the ground-

20   based receiver and the data network, the request for data received by

the ground-based receiver being sent to the data network over the circuit-switched communications network.

19. The system according to claim 18, wherein the DBS

5 satellite system uses an MPEG-2 compression technique for transmitting the requested data over the high-bandwidth communication system downlink.

20. The system according to claim 14, wherein the requested

10 data includes one of video information, audio information and textual information.

FIG. 1
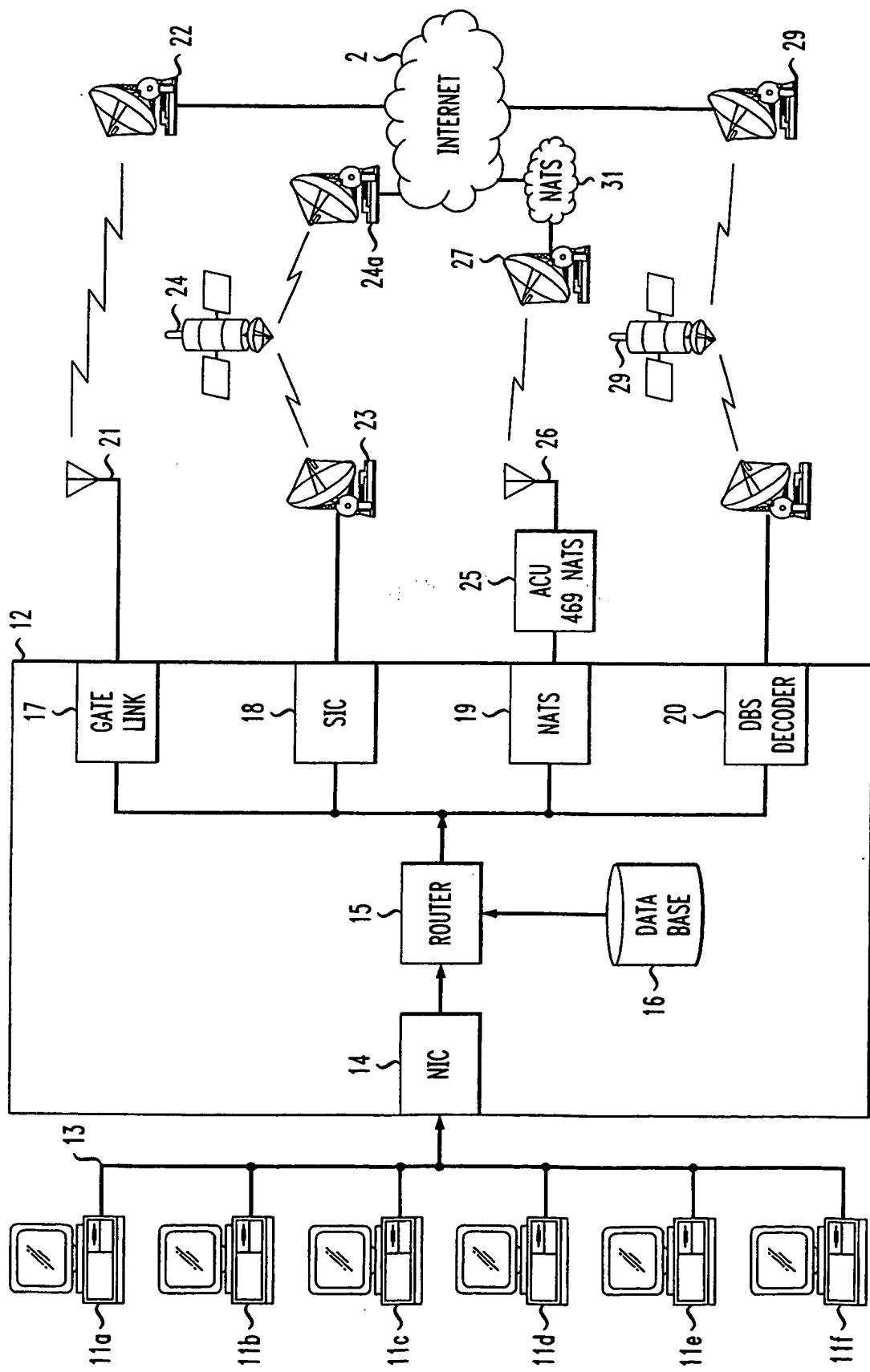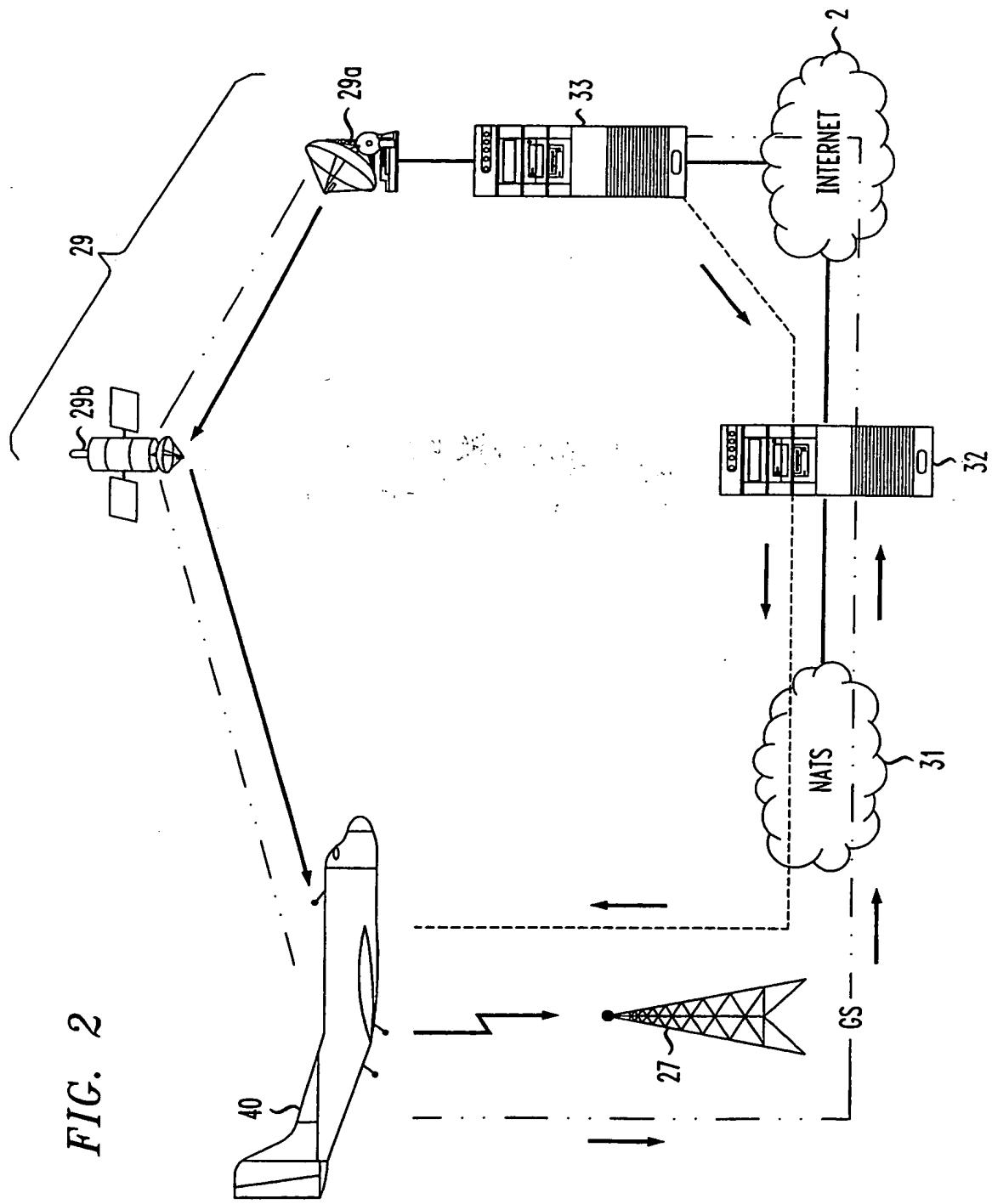
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FIG. 2

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   H04B7/185

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6   H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LOSQUADRO: "ABATE: Aeronautical Satellite Communications for Multimedia Services" IEE COLLOQUIUM ON EU'S INITIATIVES IN SATELLITE COMMUNICATIONS-MOBILE(REF. NO. 1997/087),8 May 1997, pages 7/1-7/7, XP002096609 London, UK	1-7, 10-17,20
Y	see the whole document	8,9,18, 19
Y	LOSQUADRO: "EuroSky Way: Multiregional Network for Satellite Multimedia" PROCEEDINGS OF FOURTH EUROPEAN CONFERENCE ON SATELLITE COMMUNICATIONS, 18 - 20 November 1997, XP002096610 Rome, Italy see abstract	8,9,18, 19

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[X] Further documents are listed in the continuation of box C.

[ ] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 March 1999	31/03/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Felsen, J

Form PCT/ISA/210 (second sheet) (July 1992)

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	LOSQUADRO: "SECOMS: Advanced Interactive Multimedia Satellite Communications for a variety of Compact Terminals" IEE COLLOQUIUM ON EU'S INITIATIVES IN SATELLITE COMMUNICATIONS-MOBILE (REF. NO. 1997/087),8 May 1997, pages 3/1-3/7, XP002096611 London, UK see the whole document —————	1-4,6-8, 10-14, 16-18,20

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